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**ECOLOGY AND DISTRIBUTION OF MAMMALIAN ECTOPARASITES,
ARBOVIRUSES, AND THEIR HOSTS IN VENEZUELA**

7th ANNUAL PROGRESS REPORT

by

Charles O. Handley, Jr., Ph.D.

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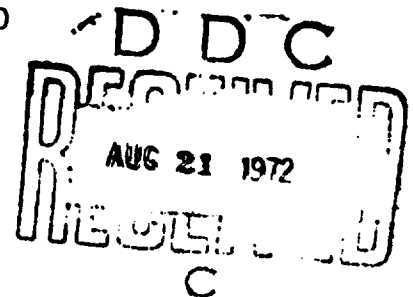
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14.

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ECOLOGY AND DISTRIBUTION OF MAMMALIAN ECTOPARASITES, ARBOVIRUSES, AND THEIR HOSTS IN VENEZUELA

ABSTRACT

A study of the ecology, distribution, and abundance of mammalian arthropod ectoparasites, arboviruses, and their hosts is being conducted in Venezuela. It is attempting to recognize and define species, to map their distribution and abundance, to discover and define dominant environmental factors limiting populations, and to analyze parasite-host-habitat relationships. During the project year 1972 preparation of specimens for study was completed on three of the four groups of ectoparasites incomplete at the beginning of the year and mammal specimen preparation neared completion. Most ectoparasite data were summarized and about half of these and more than a third of the individual host records were entered into the Project's computer data bank. Generalized statistical programs for mensural data were completed and tested and some programs were rewritten in COBOL. Identification of most parasites and hosts was completed and a master list of host identifications was constructed. Systematic studies were completed on eight parasite groups and are reported in a volume of monographs in press. Ten smaller papers were published or sent to press. Collections which have been fully studied were partitioned so that a share can be returned to Venezuela.

NARRATIVE

1. The problem

When non-immune human populations are moved into unfamiliar territory they are invariably threatened by disease. Traditionally, such movement has been accompanied by great incapacity and loss of life, a slow accumulation of epidemiological knowledge, and an even slower development of appropriate medical response. Well-documented examples of this process have been provided by the movement of American forces into New Guinea, Korea, and Southeast Asia in recent wars. The same problems face peaceful colonists, particularly those colonizing unexploited tropical regions such as Amazonia in South America and similar areas in New Guinea, northern Australia, and equatorial Africa. Ideally, epidemiological knowledge and medical expertise should precede troop movements and colonizations.

2. Objectives

In response to the problem, the objectives of this Project are twofold, technological and scientific.

A. The technological objective is to develop procedures such as pre-planned multi-discipline teamwork, standard field and laboratory techniques, and methods of data analysis that will allow relatively inexperienced personnel to adequately sample, thoroughly analyze, and satisfactorily describe a complex fauna in a brief period of time. This would lead naturally (but

beyond the scope of the present project) to recognition, definition, and solution of epidemiological problems such as means of recognizing and mapping potential danger areas, and avoiding or controlling vectors and reservoirs of disease.

B. The scientific objective of the Project is to collect and describe the mammalian and mammalian ectoparasite faunas of Venezuela and to describe their ecological relationships with one another and with the external environment. It is necessary to recognize and define species and their variation, to map their distribution and abundance, and to discover and define dominant environmental factors limiting populations. Exhaustive studies of parasite-host-habitat relationships have been carried out on a few hosts but never on an entire fauna. Such a study, utilizing electronic data processing and encompassing the fauna of a large geographic area with much physical relief and many diverse habitats, should go far toward explaining the prevalence and distribution of parasites and their hosts.

3. Procedure

To accomplish its objectives the Project was structured into several stages:

collecting
specimen preparation
data analysis
study
report
collection dispersal

Each successive stage was dependent on preceding stages. Each stage contributed to both the technological and scientific objectives. Ideally the chronology of the stages should have approximated figure 1.

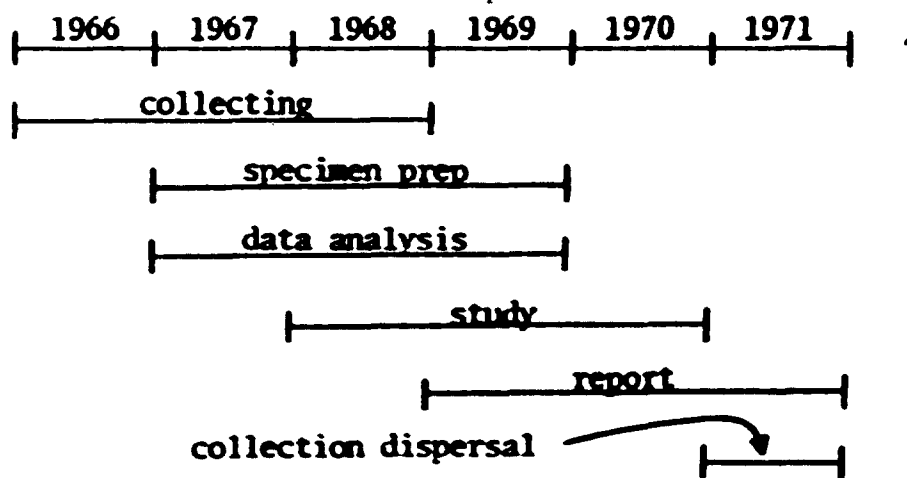


Fig. 1.

In fact, however, the chronology of stages has resembled figure 2.

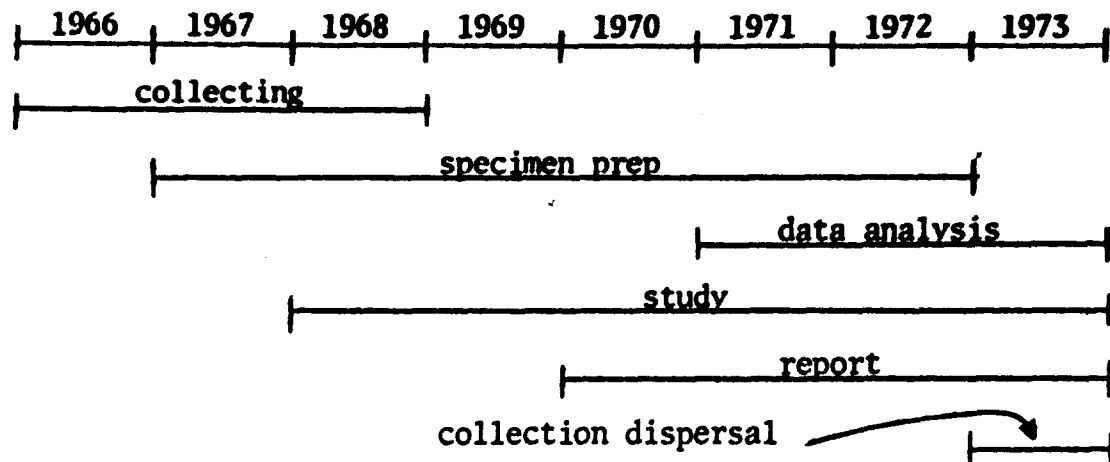


Fig. 2.

Primary causes for this departure from the ideal were the unprecedented numbers of specimens and data, often overwhelming; the exceedingly primitive state of knowledge of the fauna at the outset; and inadequate levels of funding. Only at the very beginning were there sufficient funds to accomplish the objectives of a given year. The resulting erosion of schedule greatly prolonged the specimen preparation stage and delayed the data analysis, which together greatly handicapped study and report.

4. Collecting

During the three year collecting phase of the Project large scale collecting was carried on in all parts of Venezuela. Forty-eight major collecting localities were sampled for periods of four to eight weeks each. Field personnel processed about 40,000 mammals, 25,000 vials of ectoparasites, 800 blood sera, and numerous other zoological specimens.

Detailed ecological, geographical, and biological data were entered in the field on standard forms for later conversion for computer processing and analysis. Such a procedure is necessary because the kinds and abundance of parasites associated with a particular mammalian host may depend upon a complex interaction of many factors, such as sex, age, reproductive condition, and population density of the host, as well as upon the habitat, season, and presence of other parasites.

Progress in 1972:

This stage was completed in 1968 (see Fig 2).

Remaining to be done:

Nothing.

5. Specimen preparation

A. Ectoparasites

Students at the Universidad Central de Venezuela did most of the

initial sorting of the ectoparasites. Subsequently, much of the mounting, labeling, and art work was done at the 406th Army Medical Lab in Tokyo, and at the Brigham Young University, Provo, Utah. The Project funded student technicians in the laboratories of several of the Associate Investigator scientists for further specimen preparation.

Progress in 1972:

In the 1971 annual report it was stated that, with the exception of 10% of the collection of Streblidae, all of the ectoparasites had been processed for study. Actually, some of the Trombiculidae, Dermanyssidae, and Macronyssidae had not been processed either. During 1972 those groups were mounted and labeled, but lack of funds for technical assistance prevented progress on the Streblidae.

Remaining to be done:

On several of the more difficult species of Streblidae the genitalia must be dissected out so that definitive studies of the group can be completed. About 1,000 specimens are involved.

B. Hosts

In the field most of the mammals were prepared as "skin and skull"; the smaller ones were stuffed, while the larger ones had their hides salted and dried without stuffing. About 6,000 of the hosts were preserved entire in formalin. At the Museum the latter were washed, to remove the formalin, then were stored in alcohol. The "skins and skulls" were sorted and matched, given preliminary identifications, then cataloged. The skulls were cleaned and degreased, then numbered and labeled. The larger salted hides were tanned; the smaller were desalted, relaxed, degreased, and stuffed; all were then labeled.

Progress in 1972:

- (1) About 4,800 skulls, including all remaining small skulls were cleaned, degreased, numbered, and labeled.
- (2) About 75 medium-size salted hides were desalted, relaxed, degreased, stuffed, and labeled.
- (3) Remaining large salted hides, 125 in all, were tanned, numbered, and labeled (these were overlooked in the last annual report, which stated that all large hides had been tanned and labeled).
- (4) The 6,000 specimens stored in alcohol were cataloged.

Remaining to be done:

- (1) About 200 large skulls (primates, rodents, lagomorphs) remain to be cleaned and labeled.

- (2) Of the smaller salted hides, 27 remain to be desalted, relaxed, degreased, stuffed, and labeled.

6. Data Analysis

The great volume of diverse data on parasite, host, and environment can only be adequately correlated by computer. The heart of the Project, the objective of definition of parasite-host-habitat relationships on a scale never before achieved, depends on electronic data processing. Furthermore, the data system must have retrieval formats for sorting ecological, physiological, and geographic data useful in research and in writing up the species accounts of both parasites and hosts.

In addition to mensural and taxonomic data gathered in the Museum, host data comes from data sheets which were filled out in the field by the collectors. These include host identification, age, reproductive condition, ecology of collecting area, and conditions of collection. Most of the fields are coded on the field data sheets for 80 column Hollerith card punching. The host specimen tag and the collectors' field journals are additional sources of information. Parasite data for each field number includes host species identification and number of individuals, sex, and age of each parasite by species.

To simplify the numbering of collections in the field and to facilitate cross-referencing and sorting data in the laboratory, a single set of collection numbers was used throughout the Project. Thus, any given number between one and 45,000 appears only once in the Project. A single number pertains to all parts of the host, all of its parasites, and all bits of associated ecological and biological data.

The cooperation of the Medical Research and Development Command has made it possible for the Project to use a Control Data Corporation computer with Hollerith card input to handle sorting, tabulating and statistical manipulations of all the mammal and ectoparasite data. Capt. Klaus Waibel (U.S. Army Medical R&D Command) is programming for the Project.

Some of the programs which have been completed and tested are:

- A. Listings of the complete data record for hosts and parasites.
- B. Listings of host and parasite records sorted by various combinations of habitat, collecting conditions, and other variables.
- C. Production of tabular displays of data which will include raw and percentage numbers for host and parasite data broken down into as many as 20 categories.

- D. Cumulative host identification list.
- E. Thesauri of host and parasite nomenclature.
- F. Generalized statistical analysis of host mensural data.

Mammal and ectoparasite names have been coded, programmed, and entered on magnetic tape. Copies of computer printouts in the form of mammal and ectoparasite thesauri have been distributed to all collaborators. These files are being continuously updated with changes in names and additions and deletions of names. Most host data have been edited and 24,000 individual host records have been keypunched and entered on magnetic tape. Approximately 22,500 ectoparasite records have been keypunched.

Most of the statistics that will be used in data analyses have been described arithmetically and have been programmed. A standard set of terminology for the statistical analyses has been drawn up in a form which can be easily understood both by the programmer and the collaborating scientists.

Progress in 1972:

- (1) Edited, keypunched, and transferred to magnetic tape 14,000 individual host data files.
- (2) All "negative" and "not examined" parasite records, about 14,000 in all, were edited, keypunched and committed to magnetic tape.
- (3) Most remaining parasite records (parasite name codes and number of individuals of each sex and age group, by host), 19,000 in all, were entered on intermediate cards by Dr. Tipton and his students at Brigham Young University and have now been transferred to the Smithsonian for editing, keypunching, and magnetic taping. The programmer has agreed on keypunch procedures.
- (4) With the aid of the computer a master list of hosts and their SVP numbers was constructed. This already has proved to be of great value in verifying host entries in the ectoparasite monographs.
- (5) Generalized statistical programs for mensural data were completed and tested on Bradypus and Choloepus.
- (6) Work on layouts for some of the more complex correlations of parasite-host-ecological relationships was continued.
- (7) Some of the existing programs were rewritten in COBOL to make them more efficient.

Remaining to be done:

- (1) Complete editing, keypunching, and taping the remaining 16,000 individual host data files.
- (2) Complete compilation of remaining 1,000 parasite records on intermediate cards.
- (3) Complete editing, keypunching, and taping the remaining parasite records, about 20,000.
- (4) Complete computer programming. Among the data analysis objectives remaining to be programmed, only those of the greatest practical and theoretical interest will be programmed. These will be for correlating host-parasite locality data and some of the more complex host-parasite relationships. Advice of a statistician will be sought on application of statistics to the correlations. These programs are experimental and should be of extreme interest to parasitologists.
- (5) Run statistical programs on all mensural data.
- (6) Run correlative programs on all parasite-host-habitat records.
- (7) A paper on data analysis objectives and sections on data analysis for a procedural paper will be completed.
- (8) Complete gazetteer of collecting localities, with detailed summaries of environmental data.

7. Study

Study of the Project's collections is carried on by volunteer scientific Associates (see Appendix) who receive no financial reward from the Project. The Associates have identified the specimens, recorded pertinent data for correlations, made up keys and species definitions, and put together definitive synopses for publication.

A. Arthropods.

The ectoparasite fauna of Venezuela was poorly known and to a large extent undescribed. The collections of the Project included many new species and genera, as well as previously undescribed life forms of species already known. There had been little effort previously to map distributions or relationships or to identify primary and secondary hosts. Most of the ectoparasites have been identified, and systematic studies of most have been completed. About half of the definitive monographs are in press.

Studies of the ectoparasite collections, coordinated by Dr. Vernon Tipton have progressed as follows:

Barrera: Coleoptera. Work completed, and a monograph on the Venezuelan Amblyopinini is in press. One new species of the genus Amblyopinus is described in this paper.

Brennan: Trombiculidae. All have been identified by Tipton and students who are working with Brennan to produce a monograph. Two papers have been published.

Emerson: Mallophaga. All specimens have been mounted and labeled. Most have been identified. A monograph on the Mallophaga of Venezuelan mammals is being prepared. One paper has been published.

Furman: Laelapidae. Work completed, and a monograph on Laelapidae of Venezuela is in press. At least two genera and 13 species are undescribed and there are 19 new records for Venezuela. In all about 47 species are represented among the 45,000 specimens in the collection. The most significant finding is the remarkable range of intraspecific variation in Laelaps and the related discovery of several sibling species. Two papers have been published and two others are in press.

Guimaraes: Nycteribiidae. Work completed, and a monograph of the Nycteribiidae of Venezuela is in press. Included in the collection are at least six species of Basilis, two of which are new.

Johnson, P. T.: Anoplura. Work completed, and a monograph on the "Rodent Anoplura of Venezuela" is in press. It describes numerous new species.

Kohls and Clifford: Ixodoidea. Work completed. Three papers have been published and a monograph is in press. There are nine genera of ticks with approximately fifty species represented in the material.

Maa: Hippoboscidae. All specimens have been identified and a monograph is being prepared. There are no new species, but two rare species and one commoner species were found in Venezuela for the first time. A total of 7 species are in the collection.

Machado: Spinturnicidae. All specimens have been mounted and most have been identified. A monograph is in preparation. Two papers have been published.

McDaniel: Listrophoroidea. Work completed and a monograph is in press.

Tipton: Siphonaptera. Work completed and a monograph on the Siphonaptera of Venezuela is in press. Although there are no new species of fleas there are several new records for Venezuela. In addition, the volume of material permits a better definition of the taxa represented as well as recognition of host-parasite relationships. There are about 18 genera and 35 species.

Usinger and Ueshima: Polychtenidae. Work completed, and a monograph is in press. Dr. Usinger, in a letter prior to his death, indicated that this was the largest single collection of polychtenids ever made, and that it would allow the study of host-parasite affinities which until now have been obscure. Included in the material are one genus and five species, one of which is new.

Wenzel: Streblidae. Sorting and identification have been completed and most data have been entered on data cards. To date 112 species have been recognized (at least 40 of them are new) among the 30,000 specimens of Streblidae in the Project collections.

Yunker: Dermanyssidae and Macronyssidae. All specimens have been mounted and identifications have been completed by Dr. Tipton and his students. They are working with Dr. Yunker to produce a monograph. One paper has been published.

Progress in 1972:

- (1) Completed identification of Trombiculidae, Dermanyssidae, and Macronyssidae.
- (2) Completed studies and monographs on Laelapidae, Nycteribiidae, Ixodoidea, Linstrophoroidea, and Siphonaptera.

Remaining to be done:

- (1) Complete studies and monographs on Trombiculidae, Dermanyssidae, Macronyssidae, Mallophaga, Hippoboscidae, Spinturnicidae, and Streblidae.
- (2) Correlations of parasite-host-habitat relationships. A conference of Furman, Handley, Johnson, Tipton, and Wenzel will be held at Provo late in the year, after computer analyses have been completed, to rough out a paper on parasite-host-habitat relationships.

B. Mammals.

Species must be defined, limits of variation estimated, and geographic variation mapped. Precise identification of the hosts is the central necessity of the Project. Otherwise the parasite and ecological data are meaningless. It is safe to say that less than a dozen of the several hundred species of mammals occurring in Venezuela are adequately

known taxonomically. Thus, it has been necessary to consider the identifications of the hosts collected in Venezuela to be tentative until each species can be studied in detail. Unfortunately, meaningful systematic studies on the collection could not be commenced until most of the specimen preparation had been completed. In the interim studies were made on existing collections in the USA, South America, and Europe.

Now that most of the curatorial work has been completed, studies of the systematics of the mammals of the Project's collection are under way. Dr. Ralph Wetzel, University of Connecticut, is studying the edentates, carnivores, and ungulates of the collection. He is now analyzing and writing up the results of his studies. Dr. Richard Thorington, Section of Primate Biology, Smithsonian Institution, is studying the primates of the collections, while Dr. Charles Handley is responsible for the marsupials, insectivores, bats, rabbits, and rodents. Having largely completed preliminary monographic studies of bats, Dr. Handley turned his attention during this Project Year to taxonomic studies of rodents. He made study trips, without cost to the Project, to the American Museum of Natural History, Field Museum of Natural History, and Museum of Comparative Zoology at Harvard University. Dr. Luis de la Torre, Field Museum of Natural History, is studying the genus Sturnira, one of the major groups of fruit-eating bats.

Three papers dealing with the mammals of the collection have been published and two others are in press.

Progress in 1972:

- (1) Final verification of host identities, except for those whose skulls had not been cleaned, was completed. This included all primates, rodents, and lagomorphs, and about a third of the bats, 15-20,000 specimens in all.
- (2) A master list of host identifications was compiled to aid in editing the ectoparasite monographs. This replaces the list of tentative identifications supplied to the associate investigators earlier in the Project.
- (3) Extensive synoptic notes were made at a number of museums on two large and important rodent genera, Rhipidomys and Thomasomys. These were the last large groups in the collection that had not been studied.
- (4) The collections of marsupials stored in alcohol were measured, aged, and dissected to determine reproductive condition. A start was made on the same procedures with bats (free-tailed bats, family Molossidae processed). In all, about 600 specimens processed.

Remaining to be done:

- (1) Complete verification of identifications. This includes the skulls,

about 2,000, which had not been cleaned when the rest of the collection was verified.

- (2) Complete measuring, aging, and determination of reproductive condition of the specimens stored in alcohol. About 5,400 specimens remain.
- (3) Take standard measurements on skulls for mensural analysis. About 1,000 have been done, leaving about 33,000 to go.
- (4) Complete taxonomic studies of the collections.

8. Report

The visible products of this Project are its publications. These are of three sorts, useful both to the Armed Forces and to the scientific community at large:

Scientific

Short descriptive articles

Definitive monographs

Technological

Procedural handbook

A. Short descriptive articles

A number of short descriptive articles have been published, most without cost to the Project. Each has carried the statement, "This paper is a contribution of the Smithsonian Venezuelan Project, supported by a contract (DA-49-193-MD-2788) of the Medical Research and Development Command, Office of the Surgeon General, United States Army." Eight of these papers were published prior to the present Project Year:

1. Tuttle, M. D. 1967. Predation by Chrotopterus auritus on geckos. Journ. Mammalogy, 48(2):319. (May)
2. Machado-Alfonso, C. E. 1967. The systematic position of the bats Desmodus and Chilonycteris, based on host-parasite relationships (Mammalia; Chiroptera). Proc. Biol. Soc. Washington, 80(35): 221-224. (Dec.)
3. Kohls, M., Sonenshine, E. and Clifford, C. M. 1969. Ixodes (Exopalpiger) jonesae sp. N (Acarina: Ixodidae), a parasite of rodents in Venezuela. The Journal of Parasitology. 55(2):447-452. (April)
4. Brennan, M. and Yunker, C. E. 1969. Endoparasitic Chiggers: V. New Genera, Species and Records from Venezuela and Brazil (Acarina: Trombiculidae). J. Med. Ent. 6(3):299-304. (Aug.)

5. Emerson, K. C. and Price, R. D. 1969. A New Species of Plegadiphilus (Mallophaga:Menoponidae) from the Cayenne Ibis. The Florida Entomologist, 52(3):161-163.
6. Kohls, M., Clifford, M. and Jones, E. K. 1969. The systematics of the subfamily Ornithodorinae (Acarina:Argasidae). IV. Eight new species of Ornithodoros from the Western Hemisphere. Ann. Entom. Soc. Amer. 62(5):1035-1043. (Sept.)
7. Yunker, C. E. 1970. A second species of the unique family Chirorhynchobiidae Fain, 1967 (Acarina:Sarcoptiformes). Journ. Parasit., 56:151-153, 4 figs. (Feb.) *
8. Tuttle, M. D. 1970. Distribution and zoogeography of Peruvian bats, with comments on natural history. Univ. Kansas Sci. Bull. 49(2):45-86. (Oct.)

Progress in 1972:

In addition to the eight articles published earlier, ten short descriptive scientific articles were published or submitted for publication in Project Year 1972:

9. Machado-Allison, C. E., and Antequera, R. 1971. Notes on Neotropical Mesostigmata VI. - Four New Venezuelan species of the genus Periglischrus (Acarina:Spinturnicidae). Smithsonian Contributions to Zoology, 93:1-16, 53 figs. (Aug.?)
10. Brennan, J. M. 1971. Anomalaspis ambiguus 1952, redescribed and the questionable association of South American species with Pseudoschoengastia (Acarina:Trombiculidae). Journ. Med. Ent. 8(5):602-604. (Oct.?)
11. Furman, D. P. 1971. New Species of Gigantolaelaps (Acarina:Laelapidae) from Venezuela. Journ. Med. Ent. 8(6):707-712. (Dec.)*
12. Handley, C. O., Jr. and Ferris, K. C. 1972. Description of new bats of the genus Vampyrops. Proc. Biol. Soc. Washington, 84:519-523. (Feb.)
13. Furman, D. P. 1972. New species of Laelaps (Acarina:Laelapidae) from Venezuela. Journ. Med. Ent., 9(1):35-46, 26 figs. (March)*
14. Jones, E. K., and Clifford, C. M. 1972. The systematics of the subfamily Ornithodorinae (Acarina:Argasidae). V. A revised key to larval Argasidae of the Western Hemisphere and description of seven new species of Ornithodoros. Ann. Ento. Soc. America, 65(3):730-740, 14 figs. (May)
15. Wetzel, R. M., Mondolfi, E., and Hernandez, J. The small armadillos of the genus Dasypus (D. sabanicola, septemcinctus, and hybridus) (Dasypodidae, Edentata), their biology, taxonomy, and distribution. In press.

16. Wetzel, R. M., and Felten, H. The identity of Bradypus variegatus Schinz (Mammalia: Edentata). In press.
17. Furman, D. P. A new genus and species of Laelapid mite (Acarina: Laelapidae) from Venezuelan rodents. In press.
18. Furman, D. P. A new species of Tur (Acarina: Laelapidae) from Venezuela. In press.

Remaining to be done:

Publication of the definitive monographs will complete publication plans for the ectoparasites. However, because specimen preparation is only now being completed on the hosts, research on the mammal collection will continue well beyond the life of the Project. Numerous papers are in various stages of completion or are planned. They will be published without cost to the Project, but they will be identified as contributions of the Project.

de la Torre. Venezuelan bats, genus Sturnira.

Handley. Synopses of Venezuelan Rodentia (in many parts).

Synopses of Venezuelan Chiroptera (in many parts).

Thorington. Recent Primates of Venezuela.

Wetzel. A revision of the Genus Tamandua (Myrmecophagidae, Edentata).

The distribution and classification of Dasypus kappleri (Dasypodidae, Edentata).

Review of the species of Felis in northern and middle South America (Felidae, Carnivora).

Review of the Recent Tropical Procyonidae (Carnivora).

The distribution and taxonomy of the Mustelidae (Carnivora) of northern South America.

The genus Dusicyon (Canidae) in northern South America.

The Priodontini of tropical America (Priodontes, Cabassous, Dasypodidae, Edentata).

A consideration of the small spotted cats of the Neotropics (Felis tigrina, geoffroyi, wiedii, Carnivora).

Review of the Recent Myrmecophagidae (Edentata).

Wetzel and Handley. The Recent Canidae of Venezuela.

The native ungulates of Venezuela, their habitat selection, distribution, and taxonomy.

The distribution and habitat selection of the Edentata of Venezuela.

The distribution and habitat selection of the Carnivora of Venezuela.

B. Definitive Scientific Monographs.

The major reports of the Project are its definitive scientific monographs. These summarize knowledge of each of the groups of mammalian ectoparasites and their hosts found in Venezuela. When publication is completed they will constitute a major reference source. Three volumes are contemplated: two on ectoparasites, published by the Brigham Young University Press, and one on mammals, published by the Smithsonian Press. The time consuming job of editing parasite data and checking host and locality references in the monographs is being performed by Tipton and Handley. Tipton is managing the preparation of final copy and is dealing with the publisher.

Progress in 1972:

The first volume of definitive monographs of the Project is in press. It is being published in the Brigham Young University Science Bulletin-Biological Series as volume 17 (whole volume). A late summer or early fall, 1972, publication date is expected.

The contents of volume 17 are as follows:

Foreword

Table of Contents

Number One:

- a. Ueshima, N. New World Polychtenidae: Hesperoctenes (Hemiptera), with special reference to Venezuelan specimens.
- b. Guimaraes, L. R. Nycteribiid Batflies from Venezuela (Diptera:Nycteribiidae).

Number Two:

- a. Machado-Allison, C. E., and Barrera, A. Venezuelan Amblyopinini (Insecta:Coleoptera:Staphylinidae).

- b. McDaniel, B. Labidocarpid Bat-mites of Venezuela (Listrophoroidea: Labidocarpidae).

Number Three:

Johnson, P. T. The Sucking Lice of Venezuelan Rodents, with remarks on related species (Anoplura).

Number Four:

Furman, D. P. Laelapid Mites (Laelapidae: Laelapinae) of Venezuela.

Number Five:

Jones, E. K., Clifford, C. M., Keirans, J. E., and Kohls, G. M. The Ticks of Venezuela (Acarina: Ixodoidea) with a key to the Amblyomma of the Western Hemisphere.

Number Six:

Tipton, V. J. and Machado-Allison, C. E. Fleas of Venezuela (Siphonaptera).

Index

Remaining to be done:

Volume 19 of the Brigham Young University Science Bulletin-Biological Series has been reserved for the second group of Venezuelan Project monographs. With the exception of the paper on correlation of parasite-host-habitat relationships, which will be the product of a Furman-Handley-Johnson-Tipton-Wenzel conference in the spring of 1973, all of the manuscripts for this volume are already completed or are in various stages of preparation.

Tentative contents of volume 19:

Number One:

- a. Trombiculidae of Venezuela. Brennan and Reed.
- b. Dermanyssidae and Macronyssidae of Venezuela. Yunker, et al.

Number Two:

Mallophaga of Venezuela. Emerson.

Number Three:

Streblidae of Venezuela. Wenzel.

Number Four:

- a. Hippoboscidae of Venezuela. Maa.
- b. Spinturnicidae of Venezuela. Machado.

Number Five:

Correlation of parasite-host-habitat relationships.
Furman, Handley, Johnson, Tipton, and Wenzel.

Number Six:

Checklist of the ~~mammals~~ of Venezuela. Handley.

Appendix:

Gazetteer of Venezuelan collecting localities.
Handley.

List of Smithsonian Venezuelan Project publications

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The third volume of Project monographs, The Mammals of Venezuela, is in preparation. It includes redescription of all species, keys, digest of nomenclature, distribution maps, ecological descriptions, data on reproduction and seasonality, as well as notes on natural history. It will be submitted to the Smithsonian Institution for publication.

C. Technological-Procedural handbook

The concept, scope, and objectives of epidemiological projects are described. Recommendations are made on administration, collecting techniques, field reports of data, data analysis system, laboratory processing and study of specimens, disposition of collections, and production of manuscripts. Detailed objectives for the computerized data analysis system developed for the Smithsonian Venezuelan Project are presented in the form of a model which describes the analyses used to study available data. Computer lists, tables, graphs and statistical analyses are described. Appendices will include thesauri for mammals and ectoparasites, programs, and arithmetic techniques for the statistics. These recommendations are designed to assist in establishing future epidemiological studies and to insure that maximum results can be obtained with minimum effort.

The manuscript of this handbook, authored by Handley and Ferris, will be submitted to the Research and Development Command at the end of the Project.

9. Collection dispersal

The permits to conduct studies of the mammals and their ectoparasites in Venezuela, issued by the Venezuelan government, included

the stipulation that representative collections would be returned to Venezuela at the conclusion of the Project. "Representative" was defined as one-third of the collection of each taxon, fully curated and labeled, and including samples of sex, age, seasonal, individual, and geographical variation. The holotype (or first specimen if there is no type) of each taxon is deposited at the Smithsonian Institution. So that a permanent record of each specimen of mammal may be kept in the USA, photographs and measurements will be made of each.

Progress in 1972:

Those parts of the collections on which studies have been completed were partitioned so that one-third can be returned to Venezuela. This included parasites of the groups for which monographs are in press and among the mammals the edentates, carnivores, and ungulates.

Remaining to be done:

The parasite and mammal collections not processed in 1972 will be partitioned as studies of them are completed. Each mammal will be photographed and measured.

10. Completion of Project

There is every reason to expect that this long term study can be drawn to a successful conclusion in Project Year 1973 if the Army can provide continued support. The primary need is funds for completion of collection studies and for publication. Programming, keypunching and computer time, provided during the current Project Year by the Army Medical Research and Development Command without cost to the Project, are needed to complete the data analysis objectives for the huge masses of host, ectoparasite and ecological data.

APPENDIX A

ASSOCIATE INVESTIGATORS:

Barrera, A., Ph.D., Escuela Nacional de Ciencias Biologicas, Aptdo. Postal 42186, Mexico, D. F. (Coleoptera).

Bergold, G., Ph.D., Chief, Departamento de Virologia, Instituto Venezolano de Investigaciones Cientificas (IVIC), Caracas, Venezuela. (Virology).

Brennan, J. M., Ph.D., Research Entomologist (Medical), Department of Health, Education and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Hamilton, Montana 59840. (Trombiculidae).

Clifford, C. Department of Health, Education and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Hamilton, Montana 59840. (Ixodidae).

Emerson, K. C., Ph.D., Research Associate, U. S. National Museum, 2704 N. Kensington Street, Arlington, Virginia 22207. (Mallophaga).

Furman, D. P., Ph.D., Professor of Parasitology and Chairman of Division, University of California, Berkeley, California 94720. (Laelapidae).

Guimaraes, L. R., Ph.D., Departamento da Agricultura, Caixa Postal 7172, Sao Paulo, S. P., Brazil. (Nycteribiidae).

Hayward, C. L., Ph.D., Department of Biology, Brigham Young University, Provo, Utah 84601. (Ecology).

Jameson, E. W., Ph.D., Department of Zoology, University of California, Davis, California 95616. (Myobiidae).

Johnson, K. M., M.D., Director, Middle America Research Unit, Balboa Heights, Canal Zone. (Virology).

Johnson, P. T., Ph.D., Assistant Research Pathobiologist, Division of Biological Sciences, University of California, Irvine, California 92644. (Anoplura).

Kohls, G. M., D.Sc., Sanitarian Director, Department of Health, Education and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Hamilton, Montana 59840. (Ixodidae).

Maa, T. C., 19, Lane 18, Shuangchent Street, Cnr. Chungshan N. Road, Taipei, Taiwan. (Hippoboscidae).

- Machado, C., Instituto de Zoologia Tropical, Universidad Central de Venezuela, Aptdo. Sabana Grande 10098, Caracas, Venezuela. (Spinturnicidae, Streblidae, Siphonaptera, and Tur).
- McDaniel, B., College of Agriculture and Biological Sciences, South Dakota State University, Brookings, South Dakota. (Labidocarpidae, Listrophoridae, Atopomelidae).
- Mondolfi, E., Director, Consejo de Bienestar Rural, Aptdo. Correos del Este 5407, Caracas, Venezuela. (Mammalia).
- Thorington, R. W., Jr., Ph.D., Director & Associate Curator, Primate Biology Program, Division of Mammals, National Museum of Natural History, Smithsonian Institution, Washington, D. C. 20560. (Mammalia).
- Tipton, V. J., Ph.D., Department of Entomology and Zoology, Brigham Young University, Provo, Utah 84601. (Fleas).
- de la Torre, L., Ph.D., Division of Mammals, Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, Illinois 60605. (Mammalia).
- Ueshima, Norihiro, Department of Biology, Matsusaka College, Kubo-cho, Matsusaka-shi, Mie, Japan. (Polycetenidae).
- Wenzel, R. L., Ph.D., Curator, Division of Insects, Field Museum of Natural History, Chicago, Illinois; Lecturer, Department of Zoology, University of Chicago; Research Associate, Department of Biology, Northwestern University, Evanston, Illinois. (Streblidae).
- Wetzel, R. M., Ph.D., Biological Sciences Group, The College of Liberal Arts and Sciences, The University of Connecticut, Storrs, Connecticut 06268. (Mammalia)
- Yunker, C. E., Ph.D., Senior Scientist, Department of Health, Education and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Hamilton, Montana 59840. (Dermanyssidae).